The specification was objected to, and all claims were rejected, under the first paragraph of 35 U.S.C. §112. The Office Action alleges that the specification fails to disclose how each term of the polynomial in the recursive addition step described on page 12, and shown in step 3 of the flowchart of Figure 3, is determined by the application of a formula to the preceding terms. The Office Action states that "It would require undue experimentation for one of ordinary skill in the art to preform (sic) the recursive addition step...without a mathematical function expressing how each term of the polynomial is determined based of (sic) preceding terms." It is respectfully submitted, however, that all mathematical expressions, and other information, necessary to enable one of ordinary skill in the art to practice the claimed invention are clearly set forth in the specification.

More particularly, as noted on page 12 of the specification, the recursive addition approach of the present invention allows a continuous polynomial function to be reconstructed in a piece-wise fashion, using only addition. The numbers which are recursively added are stored in a path table, such as that shown in Figure 5. The manner in which these numbers are determined is explained in detail on pages 18 and 19 of the specification, with particular reference to Figures 7 and 8. As set forth therein, the geometric design to be produced defines a set of data points for each axial component of the design. Any three adjacent data points (for example X_0, X_1 and X_2 in Figures 7 and 8) define the coefficients (a, b, and c) of a unique second-order polynomial that represents a curve passing through these three data points. Since the values of the data points are known, the coefficients can be determined using the known techniques for solving quadratic equations. Once the coefficients are determined, the values (x_n, v_n, a_n)

to be stored in the path tables are calculated according to the formulas set forth on page 19 of the specification. It can be seen, therefore, that the specification clearly sets forth the mathematical functions which express how each term of the polynomial is determined. Accordingly, withdrawal of the objection to the specification, and the rejection of the claims, under the first paragraph of 35 U.S.C. §112, is requested.

Claims 4-10 and 14-15 were rejected under the second paragraph of 35 U.S.C. §112 as being indefinite. With respect to claims 4-10, the Office Action states that the first two steps recited in claim 4 are not related to each other. It is respectfully submitted that the claimed step of determining at least one of a desired position and desired velocity, recited section (b)(i) of claim 4, clearly flows from the first recited step of determining desired movement of the device along each of the axes of motion. However, in an effort to advance prosecution and obviate the rejection, claim 4 has been amended to explicitly recite that the step of determining at least one of a desired position and desired velocity is carried out on the basis of the desired movement determined in step (a).

With respect to claim 14, the Office Action states that the claim language is vague because a machining step can perform the step of removing some of the material from the block, but a representing step cannot. In making this rejection, it is respectfully submitted that the Examiner is interpreting the recited step of "representing each of the position values along the respective axes in a tangible media" in an overly restrictive manner. As set forth in claim 11, this claimed "representing" step encompasses any of a number of different operations by which a geometric design can be tangibly presented.

One such operation is to form a block of material into the shape of the design, by a machining process. Another form of representation is to display the geometric design on a screen, such as a cathode ray tube, by controlling the electron gun which activates the phosphors of the surface of the tube. Thus, it is respectfully submitted that the step of "representing", as recited in claim 11, includes a process of machining a block of material.

In any event, as explained in greater detail hereinafter, the subject of claim 14 has been incorporated into claim 11, so that claim 11 explicitly recites the movement of a tool, i.e. a machining process. In amending claim 11 to incorporate the additional subject matter, the term "representing" has been deleted, and therefore the ground of rejection is believed to have been overcome.

Claims 1-6 were rejected under 35 U.S.C. §102(b) as being anticipated by the Daggett patent. It is respectfully submitted, however, that the Daggett patent neither discloses nor otherwise suggests the subject matter of the rejected claims. For example, claim 1 recites, among other features, "a single computational resource ... for receiving feedback information from each of said feedback devices and for controlling the operation of each of said motors to provide coordinated relative moment between the tool and the workpiece along each of said multiple axes." Similarly, claim 4 relates to a method for providing coordinated movement of a device along multiple axes of motion by means of a single computational resource. Unlike the present invention, the Daggett patent is not directed to the use of a single computational resource to control multiple axes of motion. In fact, the Daggett patent explicitly teaches the opposite. Note, for example, column 5,

lines 52-58, which refer to "multiprocessor architecture," and column 6, lines 52-59, which refer to "partitioning of programming among various microprocessors."

The rejection of claims 1-6 refers to various features disclosed in the Daggett patent. However, the rejection does not indicate how the Daggett patent might be interpreted to anticipate the claimed features noted above. One of ordinary skill in the art who was attempting to control multiple axes of motion by means of a single processor would not be inclined to refer to the Daggett patent as teaching such a concept. Accordingly, reconsideration and withdrawal of the rejection of claims 1-6 on the basis of the Daggett patent is respectfully requested.

Claims 1-6 were also rejected under 35 U.S.C. §102(b) as being anticipated by the Woodman et al '603 patent. As noted above, one of the primary features of the present invention is to provide complete control of a machining operation with the use of only a single computational resource, such as a microprocessor. In a preferred embodiment of the invention, the microprocessor performs not only coordinated control of a tool along multiple axes of motion, but all aspects of a CAD/CAM operation. Thus, not only does the microprocessor control the various motors which drive the tool and/or workpiece along respective axes of motion, but it also serves as the host by which information describing a desired shape is entered into the system and, in response to this information, it produces data that describes a sequence of operations to be performed by the motors, to generate a desired shape within a formable material.

It is respectfully submitted that the Woodman et al patent does not disclose a system in which a single microprocessor provides all of these functions. Rather, the

various functions are separately carried out by different controllers in the Woodman et al system. Note, for example, that a host computer 40, separate from the CPU-based controller 30, is used to provide information indicating the sequences of lines and arcs that are necessary to cut a desired part (column 6, lines 10-14). As further described in column 6, lines 15-27, a number of the calculations relating to a cutting operation are carried out ahead of time in the host computer 40, and then provided to the controller 30 during the cutting operation. Thus, the Woodman et al patent does not disclose a system in which a single computational resource is used to carry out all phases of a CAD/CAM operation of the type set forth in claims 1-3, 18 and 19.

Another significant difference between the present invention and the system disclosed in the Woodman et al patent is the robustness with which the present invention performs, and its practical applicability to a machine tool operation. The system disclosed in the Woodman et al patent is designed to control a cutting torch (column 3, lines 50-51). The control of a cutting torch calls for much less precision than that required for a machine tool. For example, a cutting torch typically requires accuracies of only about 0.125 inch, whereas the worst case control for a machine tool is 0.0005 inch. In a flame cutting operation, there are no torque disturbances applied to the tool itself, since it never contacts the workpiece. Thus, a control system such as that disclosed in the Woodman et al patent is not designed to reject external disturbances. In contrast, in a machine tool application, the tool is constantly encountering different torque disturbances due to its contact with the workpiece.

The present invention provides a particularly robust control mechanism that enables the servo system to readily adapt to changing external forces. This robustness is brought about, at least in part, through the adaptive variation in the center value of the pulse-with modulated signals that control the motors providing the axial motion. This adaptive process was recited in claim 6, which has now been incorporated into claim 4. Although claim 6 was rejected as being anticipated by the Woodman et al patent, it is not at all apparent from the Office Action how the patent was being interpreted to anticipate this claimed subject matter. If the rejection based upon the Woodman et al patent is maintained, the Examiner is respectfully requested to point out, with particularity, the portion of the Woodman et al patent which is deemed to anticipate the subject matter recited in original claim 6.

Claims 11-17 were rejected under 35 U.S.C. §101 as allegedly being directed to non-statutory subject matter. The line of cases pertaining to the patentability of software-related inventions, many of which are cited in the Office Action, have brought about a fundamental test for determining whether any particular claimed subject matter is statutory. This test is succinctly set forth in footnote 4 of the relatively recent Federal Circuit case of In re Grams, 12 USPQ2d 1824 (Fed. Cir. 1989). There, the court stated that 35 U.S.C. §101 only requires that the physical steps in a claim (without the algorithm) constitute a statutory process, and that the algorithm operates on a claimed physical step. Claim 11 has been amended to clearly recite that it is directed to a statutory process, i.e. "a method for controlling a cutting tool to generate a geometric design in a block of formable material." Furthermore, the algorithm recited in the claim

is clearly applied to the claimed physical steps, in that the tool is moved to locations that are determined by each of the position values calculated according to the algorithm. Accordingly, it is respectfully submitted that claim 11, and its dependent claims 12-17, meet the requirements for patentable subject matter under 35 U.S.C. §101.

It is respectfully submitted that new claims 20-23 also meet the requirements of 35 U.S.C. §101. More particularly, the claims recite the physical process of controlling a device which produces a tangible representation in a medium, and the claim further recites that the successive position values which are computed in accordance with the claimed process are applied to the control of the device. Thus the two requirements of the test for statutory subject matter are met by the new claims.

Reconsideration and withdrawal of the rejections of the claims, and allowance of all claims pending in the application are respectfully requested.

Respectfully submitted,

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